HOME VEGETABLE STORAGE

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HOME VEGETABLE STORAGE
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INTRODUCTION

Many homeowners want to store home grown or bulk-purchased vegetables for the winter months. Special storage conditions, not normally found in the home, are required to maintain the quality of stored vegetables. The environmental conditions necessary for successful storage vary with each vegetable. The facilities necessary for home storage may range from simple to complex. Consequently, the price can range from inexpensive to expensive. A simple storage can provide high quality stored produce. The more expensive storages allow produce to maintain its quality for a longer period of time. Space, food requirements and economics will dictate which facility is more suitable. An understanding of vegetable storage requirements and a well-designed storage facility will give the homeowner satisfying and economical results.

This pamphlet is intended as a guide to the homeowner who wishes to store garden or bulk-purchased vegetables. It outlines the types of storage structures, storage requirements of the most commonly stored vegetables, home storage management, and design and construction details for several types of home storage facilities.

VEGETABLE STORAGE REQUIREMENTS

All vegetables that can be stored have specific environmental requirements that must be satisfied in order for the product to retain the qualities that the homeowner desires. The environmental conditions that must be controlled include temperature, humidity, ventilation and light.

Vegetables and fruits can be classified into four main groups according to their environmental requirements for storage (Table 1).

Temperature

Temperature has the greatest influence on the storability of vegetables. The ideal temperature will control respiration, disease and sprouting, yielding the best quality produce over a long storage period. When the ideal temperature cannot be achieved, it is important to try to maintain a steady temperature.

The temperature of the storage facility should be closely monitored. Use an accurate thermometer located where it is convenient to read, but near the floor where the coldest conditions occur.

Temperature control usually implies cooling. It is seldom necessary to add heat to a vegetable storage except in extremely cold weather or for inadequately insulated storages. To cool a storage ventilate with cold outside air or use refrigeration.

In non-refrigerated storages, the object is to lower the temperature in the fall. Ground or basement wall temperature may be as high as 12°C when a 5°C storage is desired. To lower the temperature, ventilate with outside air on cool nights by opening vents or outside doors. Close the storage during warm periods. Manual vents may require a lot of attention; temporary or permanent fan ventilation may be

Table 1. Storage conditions for selected fruits and vegetables

Storage Group	Produce	Temperature (°C)	Relative Humidity (%)	Storage Period (months)
	Apples	0-1	90-95	varies up to 12 months; highly variety dependent
Cold and humid	Beets			4-6
	Cabbages			2-6
	Carrots	0-1	95 +	4-6
	Parsnips			2-5
	Radishes			3-5
	Turnips			4-6
Cool and humid	Potatoes - seed	4-5		
	- table	5-7	90-95	5-10
Cool and dry	Winter Squash	10-12		4-6
	Marrow		70-75	4-6
	Pumpkins			2-4
Cold and dry	Onions - cured	0-3	70-75	4-8

more effective. Snow can be shovelled into a storage for both cooling and humidifying.

Cool produce before placing it in storage. Try to harvest root crops or cabbage as late in the season as practical, or in the early morning when they are coolest.

Check the storage occasionally to make sure that freezing does not occur. Emergency heat can be provided by a small electric heater or by opening the storage door of a basement cold room.

Ventilation

During storage a small amount of ventilation is required to ensure that oxygen is readily available to the vegetables and that carbon dioxide, heat and odors are removed. Regardless of what type of cooling system is used, a small amount of fresh air from the outside is desirable. Venting the storage room for five to 10 hours a week is usually adequate. If outside air temperatures are above the storage temperature desired, close the vents. The storage can be aired at night when temperatures are cooler.

Vegetable bins should be slatted and raised slightly off the floor so that air can move freely under and through the pile. If produce, such as carrots, are stored in plastic bags, perforate the plastic bags to allow for adequate ventilation.

Humidity

Vegetables are typically 80 to 90 per cent water. If the air surrounding the stored produce is dry, water will evaporate from the vegetables. High humidity is therefore desirable for most crops (Table 1). Some water loss will occur even in storages with high humidity.

Since ventilation removes moisture, humidity should be added to the storage when ventilation is required. Wet the storage walls and floor before harvest. Humidity can be added during the storage season by placing a tub of water in the room and hanging an old blanket draped in the water so that it acts as a wick. Using small household mister-type humidifiers is an excellent way to provide humidity. Storing root crops in perforated plastic bags allows the vegetables to breathe while retaining moisture. Storing in damp sand is effective but requires more work. Covering bins with plastic sheeting also reduces moisture loss from vegetables.

Compatibility

Certain vegetables and fruits should not be stored together because of differing storage requirements, such as temperature and humidity. Squash cannot be stored with root crops because it requires a higher temperature and lower humidity. Certain vegetables and fruits cannot be stored together because they give off byproducts that can impart objectionable tastes to other produce. For example, apples and pears produce ethylene which causes carrots to become bitter if they are stored together for a period of time. Consult Table 1 to determine if vegetables have compatible storage requirements.

A one-room cold room presents a problem for storing a variety of vegetables. Potatoes store best at a temperature of 5-8°C(41-46°F), while root crops store best at 1°C(34°F). The practical compromise is to keep the storage at 4-5°C(39-41°F) and the humidity high ; root crops will keep almost as well and potatoes will not be harmed by too low a temperature.

Potatoes should be dug about three weeks earlier than root vegetables and cabbage. They are then placed in storage and allowed a two week curing and healing period at 12-15°C(54-59°F) before the store room is cooled to a winter storage temperature of 4°C(39°F).

TYPES OF STORAGES

There are four types of storages: root cellars, basement cold rooms, buried containers, and refrigerators or coolers. Each has certain applications and advantages. Ideally, one would need three or four rooms to store all crops under proper conditions; however, most people have only one common cold storage for root crops, cabbage and potatoes. Squash, marrow and onions are stored in a drier part of the basement or workshop.

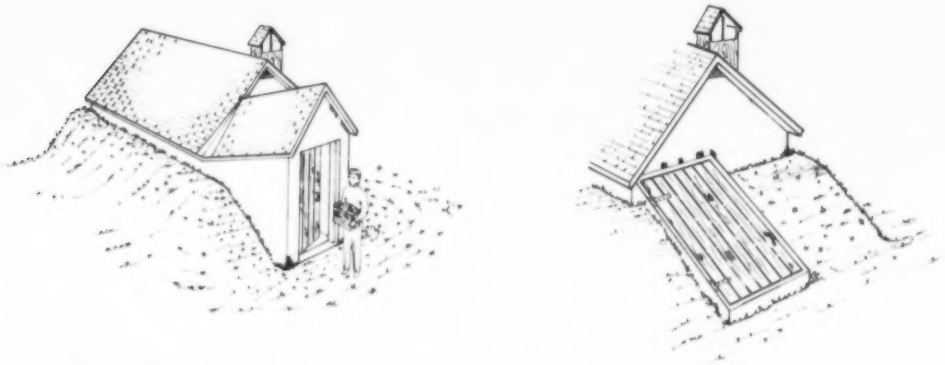
HOME STORAGE COMPARISON CHART

STORAGE TYPE	ADVANTAGES	DISADVANTAGES
Buried container	- convenient at harvest - cheap - good conditions for root crops	- less convenient during winter - small quantities only - limited to root crops - risk of frost or rodent damage
Root cellar	- may be small or large - good storage conditions for long period - handling and mess kept outdoors - reasonable cost for larger storages	- requires a yard space - not as handy during winter - high cost if a very small storage
Basement cold room	- most convenient - can be refrigerated - reasonable cost, easy to construct - versatile, (stores canned goods, pop, etc.)	- poorer warm season temperature control (unless refrigerated) - takes up house space - "messy" at harvest
Refrigerator (old)	- convenient - can be cheap - instant storage	- limited amount of storage - old 'fridge may fail - humidity control poor (store in plastic bags)

Basement cold room

A basement cold room is the most versatile of the storage types and is the most convenient for winter access. It is particularly suited to urban lots where a root cellar would be impractical. Unless it is refrigerated, a basement room may not stay quite as cool as a root cellar in early fall and late spring. A small basement cold room can store a fair amount of produce, but space may be limited compared to a root cellar. One disadvantage of the basement cold room is that vegetables must be brought into the house and there is a certain amount of mess associated with this.

Basement cold rooms can be built with well insulated inside walls and the cold basement wall on the outside. Most houses have a convenient corner or niche, such as under a porch or stairs, for locating a cold room.

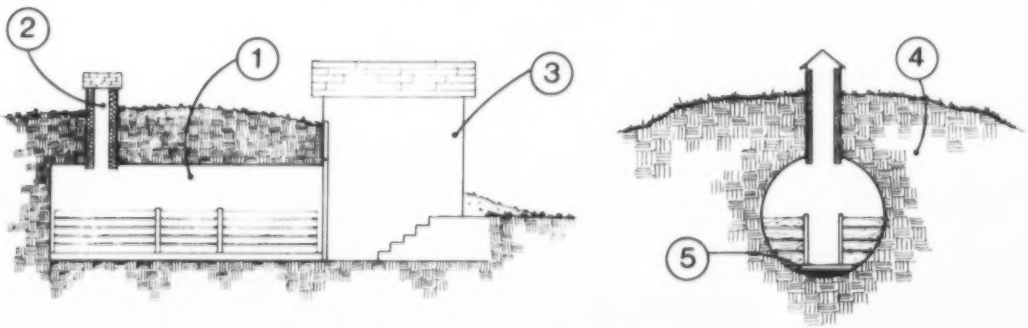


ROOT CELLARS

Root cellar

A root cellar provides good cold storage conditions. It can easily be built as large as necessary. The advantage of this type of storage is that vegetable harvest, cleaning and sorting is kept away from the house. However, access to a root cellar may not be convenient during winter, and a source of electric power to the building may cause a slight inconvenience.

Root cellars can be built from a variety of materials - usually concrete, masonry or "wood basement" treated wood. Do not use penta or creosote-treated wood, as in railroad ties. A hillside location is ideal, but not essential. An excellent root cellar can be constructed from a large-diameter steel culvert set into a hillside.



Underground Culvert Storage

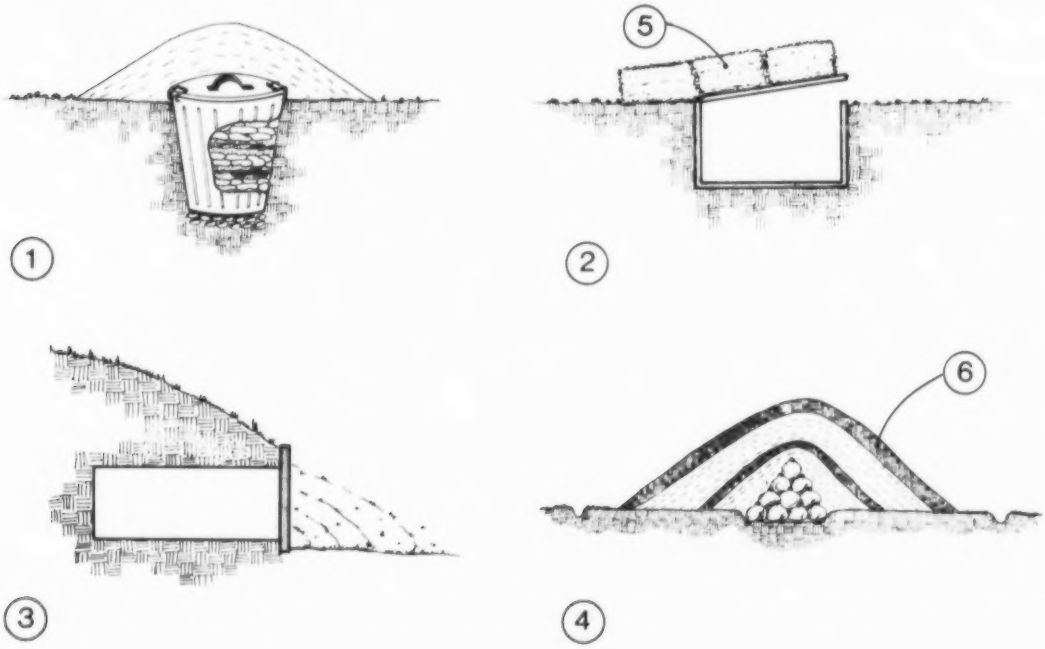
1. 1.8 - 2.4 m (6' - 8') culvert
2. insulated vent
3. entry room
4. 1.0 m (3 ft) earth cover
5. concrete or plank floor

Refrigerators

Used refrigerators or retail store coolers are excellent for storing small quantities of root vegetables. They are convenient to use, but limited in capacity to only 100-200 kg (200-400 lb) of vegetables. Operating temperatures should be checked regularly. Vegetables stored for a long time in a refrigerator or cooler must be kept in perforated plastic bags to prevent moisture loss.

Buried containers

A variety of containers such as plastic garbage pails, culverts, and old freezers can be used for storing root vegetables in the ground. (Remove the freezer latch for child safety). These are covered with a deep layer of straw or leaves after the ground has cooled to near freezing. It is most important to keep the produce cool but above freezing. Because buried containers are not very convenient or accessible during the winter, their capacity and use is limited. Rodents getting at the vegetables can also be a problem.



Buried Containers

1. Plastic Pail
2. Old Freezer or Wooden Box
3. Short Section of Culvert
4. Insulated Earth Mound
5. Straw Bales or Similar Refuse
6. Soil Cover

STORING VEGETABLES

Sanitation

Many disease problems in storage can be avoided by practising good sanitation within the storage. Storages should be cleaned as soon as the previous year's vegetables have been removed. All plant material should be removed and floors and walls swept clean. Shelving and bins should be scrubbed with soapy water and sanitized with a bleach and water solution (one part household bleach to 10 parts water). The storage should then be aired and repairs made.

Preparing vegetables for storage

The goal of storage is to allow vegetables to retain their high quality for as long as possible. Information on vegetable varieties suitable to a local area is available from district agriculture offices. Grow vegetable varieties that are suitable for storage. It must be remembered that the quality of the produce will not be improved during storage but will decrease with time. However, this can be slowed down by following the appropriate storage guidelines.

Mature vegetables free from cuts and bruises store best. When produce is harvested, avoid unnecessary damage by tools and equipment such as punctures, bruising and skinning. Avoid bruising caused by dropping the product against hard surfaces. Damaged produce need not be discarded if it can be stored separately and consumed first.

Produce should be clean and free from large clods of dirt. Root crops can be washed, but they must be dried before being put into storage. If the product is wet, lay it out on a floor on newspaper or dry it with a fan.

Avoid storing produce that is diseased or has insect damage. This produce will not last long in storage, and disease will spread to healthy vegetables. By rotating the location of vegetables in the garden many disease problems can be avoided. For other disease control measures seek advice from your local Department of Agriculture office.

Curing

Potatoes, onions, pumpkin and winter squash need to be cured either in the field or when they are first placed in the storage. Curing allows the vegetable to heal wounds and set the skin. Information on curing and handling each crop is included in the following section.

Cabbage

Only late season cabbage varieties should be stored. Heads can be harvested in late September to early October. Damaged outer wrapper leaves should be removed and discarded. Cabbage heads can be stored in slatted bins or in plastic mesh bags. To maintain optimal quality, cabbage should be stored at 0-1°C (32-34°F) and 95 per cent relative humidity (R.H.).

Carrots, parsnips, rutabagas and beets

Carrots, parsnips and rutabagas and beets can be dug from late September to early October. Carrots and parsnips can be washed but must be dried before being placed in storage. Trim stem tops of root crops to just above the root. For optimal quality, store root crops at 0-1°C (32-34°F) and 95 per cent R.H. Carrots and parsnips can be stored in plastic bags with numerous perforations. Avoid storing vegetables in dark colored plastic trash bags as these can give an objectionable taste to the vegetables.

Onions

Onions should be seeded as early in the season as possible to ensure a mature crop. Harvest the onions when two-thirds of the stems are down. Do not break stems as this encourages disease to develop later in storage. Immature onions should be consumed first. After curing store the onions at 0-1°C (32-34°F) and 75 per cent R.H. They can be stored in slatted wooden bins or in open mesh bags.

Potatoes

Potatoes should be dug in early to mid-September. Cut the vines seven to 10 days before harvest to improve the skin set. Try not to damage potatoes at harvest. Avoid digging when the soil is wet or colder than 5°C (41°F). Tubers should be cured at 12-16°C (54-61°F) and 90 per cent R.H.before storage to heal wounds and set the skin. Store potatoes for cooking in the dark at 5-7°C (41-45°F) and 90-95 per cent R.H. Storage in the dark is necessary to prevent greening of the tuber skin. Potatoes stored at too cool a temperature will convert starch reserves to sugar. To improve the color and flavor remove tubers from storage seven to 10 days before use and store them in the dark at room temperature. This will ensure that the potatoes are not sweet when cooked or turn dark brown when fried. Potatoes can be stored in wooden bins or in clean burlap sacks.

Winter squash and pumpkin

Winter squash and pumpkin should be harvested in early September before the first heavy frosts. Only mature squash and pumpkin should be stored. Mature fruit can be recognized by color; also the rind is hard and cannot be scored when pressed lightly with the edge of a fingernail. Winter squash and pumpkin store ideally at 10-12°C (50-54°F) and 75 per cent R.H. They should be cured before storage. Store in shallow slatted bins or on a shelf. Do not pile more than 60 cm (24 in.) deep.

Storage diseases and disorders

Carrots

Cottony soft rot

- This disease is readily recognized by the presence of a white cottony looking mass on the surface of the carrot. Often black raisin-like structures are seen in the white mass, and carrots become soft and watery. Cottony soft rot is caused by a fungus that can grow quickly even at low storage temperatures. This fungus is found in garden soil and is present on the carrots when they are brought in from the garden.

Grey mould

- Infected carrots at first appear light brown and water soaked, but later become spongy and leathery. The surface of the carrot is covered with a grey-brown mass of fungus. The fungus can be brought into the storage on the surface of the carrot or from other vegetable material. Dead plant material left from the previous year or poorly sanitized storages can also be a source of the disease.

Soft rot

- Soft rot is caused by bacteria. Infected carrots become soft, watery, and are foul-smelling.

Control measures for carrot diseases:

- Avoid bruising and wounding during harvest.
- Carrot storages and holding containers should be thoroughly washed and disinfested prior to use.
- Avoid storing wet carrots.
- Remove infected carrots from the storage as soon as symptoms are seen.
- Avoid planting in the same spot two years in succession.

Cabbage

Grey mould

- This disease spreads rapidly through stored cabbage causing a brown soft rot. Usually a gray-brown, felt-like mass of fungus appears on affected parts. The fungus that causes this disease enters the cabbage through bruises and wounds. The rot is restricted to the outer leaves. It is brought into the storage on the cabbage or can be found on old dead plant material left in poorly sanitized storages.

Dark leaf spot

- This disease is caused by a fungus which infects the plant leaves in the garden. Infected leaves have a dark brown or black discoloration and a dry leathery texture.

Soft rot

- Cabbage heads become soft and mushy. The disease is caused by bacteria that infect the cabbage head through wounds and bruises.

Control measures for diseases of cabbage:

- Avoid storing cabbages that have been wounded or bruised.
- Trim diseased outer leaves from cabbage heads before storing.
- Clean and disinfest storage before storing cabbage.
- Remove infected plants when symptoms are observed.

Potatoes

Bacterial soft rot

- Bacterial soft rot can be caused by several soil-borne bacteria. Tubers are infected through the potatoes' breathing pores as well as through bruises and wounds. Blisters on the infected area collapse to produce sunken areas, giving the tuber a pock-marked appearance. When the blisters are broken and the tuber is squeezed, rotten tissue squirts out. The ooze is at first cream colored but later becomes dark and foul-smelling. The disease can occur on either frost-damaged or wet potatoes that are put into storage.

Dry rot

- Dry rot is caused by a soil-borne fungus that infects tubers through wounds or bruises. Dry rot may first become evident as a clearly visible shrinking and darkening of part of the tuber, or it may progress toward the centre of the tuber and serious decay may start before external symptoms become visible. A cavity covered with a white cottony mass may form inside the potato.

Greening of potatoes

- Potatoes not totally covered by soil in the garden or left in a room exposed to daylight or artificial room lights may develop a green color. The potatoes should not be eaten if the tuber flesh is green as toxic chemicals are often found in association with green tubers.

Blackheart of potato

- A dark black spot is present in the center of tubers when they are cut open. This disorder is caused by lack of oxygen during storage.

Control measures for diseases of potatoes:
- Avoid damaging or bruising potatoes during harvest.
- Avoid digging potatoes when the soil is wet.
- Dry potatoes that are wet before storing.
- Store potatoes in the dark.
- Cure potatoes before storage at 12-16°C (54-61°F) for seven to 10 days to promote wound healing.
- Provide adequate ventilation.

Onions

Neck rot

- Neck rot of onions is caused by a fungus that can be soil-borne or transmitted through onion seed. Infected bulbs look sound and healthy going into storage but eight to 10 weeks later become brown and discolored inside.

Soft rot

- Soft rot is a bacterial disease caused by soil-borne bacteria. Infected onion bulbs are soft and have a water-soaked, yellow-grey appearance. When squeezed a foul-smelling liquid is emitted. Bacteria infect the bulb through wounds made in the bulb and the neck and also through wounds made by the onion maggot.

Control measures for diseases of onions:
- Grow early maturing varieties that are tight necked, and seed as early in the season as possible.
- Avoid fertilizing with nitrogen after July.
- Onion bulbs should be lifted and cured when two-thirds of the tops are down.
- Control onion maggots.
- Avoid injury during cultivation, harvesting and storage.
- Cure onions at 26-30°C (79-86°F) for seven to 10 days.

Winter squash and pumpkin

Soft rot

- The rind at first appears water-soaked but soon breaks down into a watery, foul-smelling mass.

Cottony soft rot

- The rind develops water-soaked spots but is later covered by a cottony, white, fungal mass.

Frost damage

- Frost damage causes the rind to develop water-soaked spots which become soft in storage.

Control measures for diseases of winter squash:
- Store mature winter squash.
- Avoid bruising or wounding the rind.
- Pile no deeper than 60 cm (24 in.).

CONSTRUCTION DETAILS

Small root cellar

Though there are several variations in root cellar construction, the basic principles illustrated here apply to most. Root cellars can be either partially below ground, with a permanent gable roof and insulated attic, or entirely below grade covered with insulation or baled straw and soil. Both styles are illustrated.

Choose a site with good drainage, avoiding a high water table that could flood the cellar. A hillside location is best when the cellar is buried, but any site can be made to work. Concrete, masonry block, or "wood basement" grade treated wood can be used. Details for both are illustrated. A concrete root cellar is built exactly like a small basement. Likewise for a masonry block root cellar, except that reinforcing rods and concrete fill should be placed in every fourth vertical row of block to withstand earth pressure.

Another type of root cellar can be built by setting a large diameter steel culvert or some well cribbing horizontally into the ground. A vent flue at the back end and an insulated entry are all that is required to make an excellent storage. A flat floor can be made in the culvert with a plank or by putting a thin concrete layer on crushed rock fill.

Treated wood approved for wood basements (must be stamped/certified PWF-preserved wood foundations) may be used, provided vegetables are not in direct contact with the treated wood. Do not use any other type of treated wood. Besides the health hazard, some types of treated wood (notably power poles and railway ties) give off odors which are picked up by vegetables and give them a bad taste.

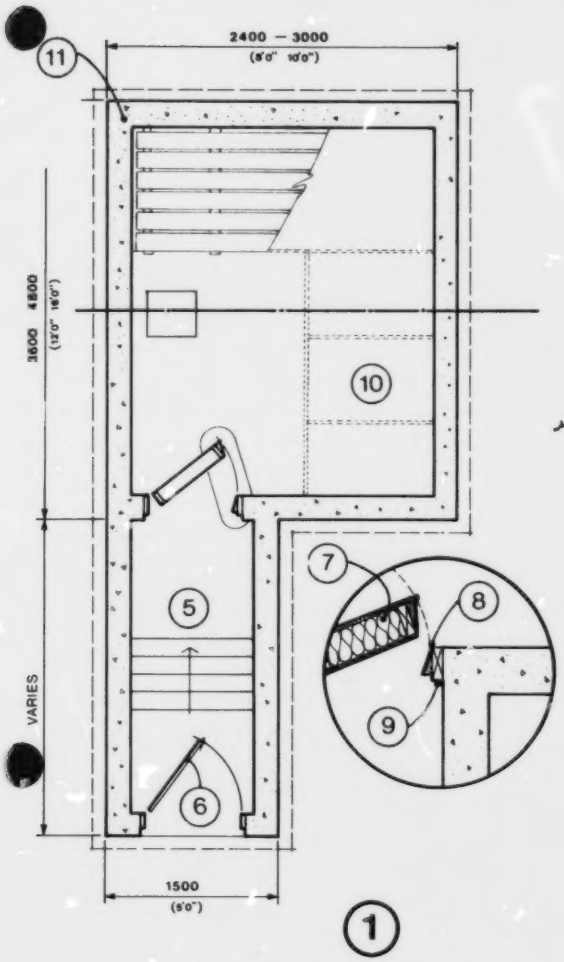
The base of the stud wall must be securely anchored in the soil, or a concrete floor laid to resist earth pressure. Likewise, the ceiling joists or roof must brace the top of the wall.

The walls of a storage that is partially below ground must be well insulated on the exterior to prevent freezing. For concrete or masonry, use 75-100 mm (3-4in.) of water-resistant foam insulation (Dow SM or equivalent). One layer of insulation may be set in the forms when the concrete is poured where it will bond securely, or it may be attached later with foam plastic adhesive.

A standard basement height of 2.4 m (8 ft) is convenient for most root cellars. The root cellar can have an earth floor. A below-floor sump is recommended if there is any danger of a high water table.

The front entry of any root cellar requires special attention to ensure the exposed wall is insulated. For most Canadian climates a double entry is preferred for cold weather use.

The roof or attic must be well insulated, to at least RSI 5.0 (R30); more where -35°C (-31°F) weather is encountered. For cellars with a roof and attic, ample insulation can be added. An inside vapor barrier is essential to maintain high humidity and to keep moisture out of the insulation. Straw bale roofs can be used (flax straw preferred), but the straw will need replacing every five to 10 years.



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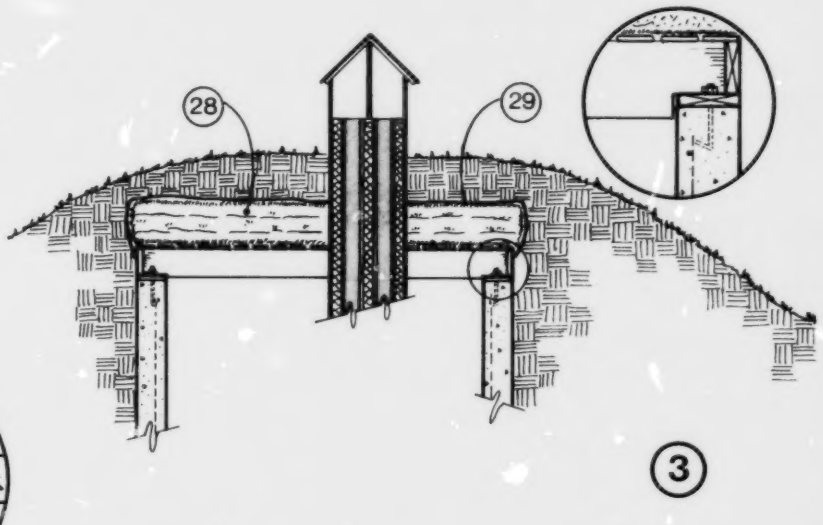
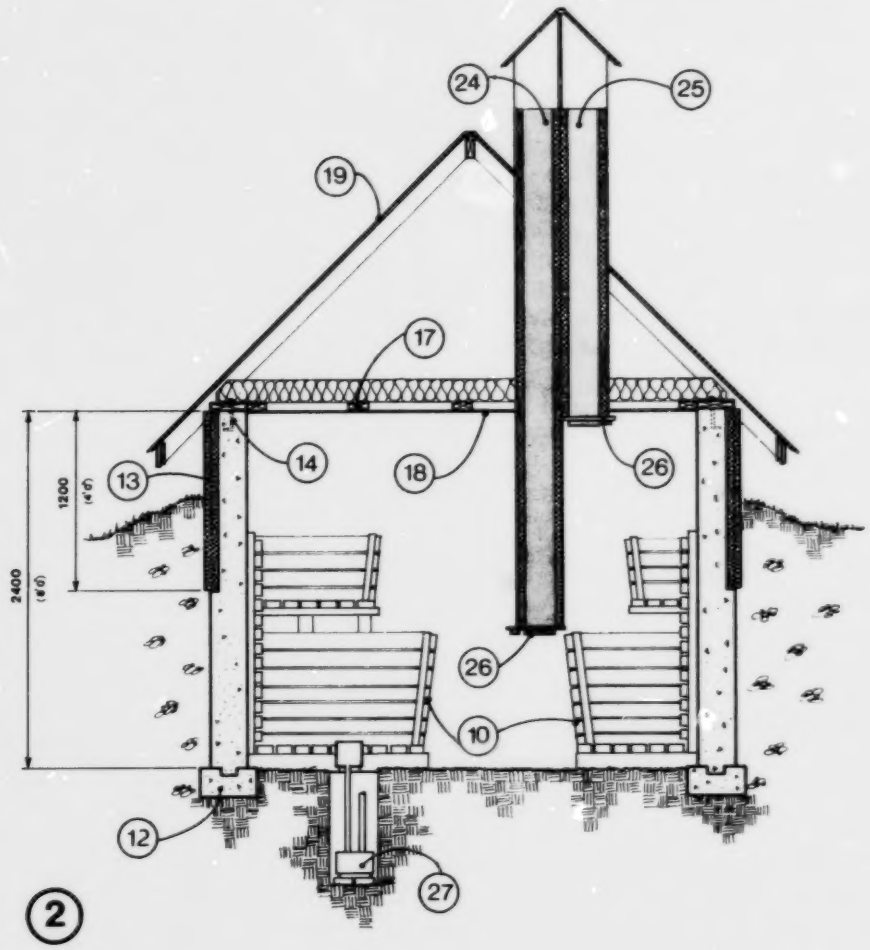


3

SMALL ROOT CELLARS

1. plan view, size is typical
2. store room cross-section
3. roof construction - insulated attic
4. alternate wood basement foundation 2 x 8 CCA treated studs @ 400 mm (16") oc
5. front entry of treated stud frame or concrete; length varies with depth
6. exterior door
7. insulated interior door
8. weather stripped, tapered frame
9. caulk all around
10. bulk storage bins; slatted floor and space at outside wall
    concrete or masonry foundation wall; if concrete block, fill cores and reinforce with 2 - 10 M
11. rebar every 1.2 m (4' - 0") oc
12. 200 x 400 mm (8" x 16") footing
13. 100 mm (4") rigid foam insulation in two layers; protect with treated plywood, suitable plaster or cement asbestos board
14. 15 mm (5/8") anchor bolts 1.2 m (4' - 0") oc



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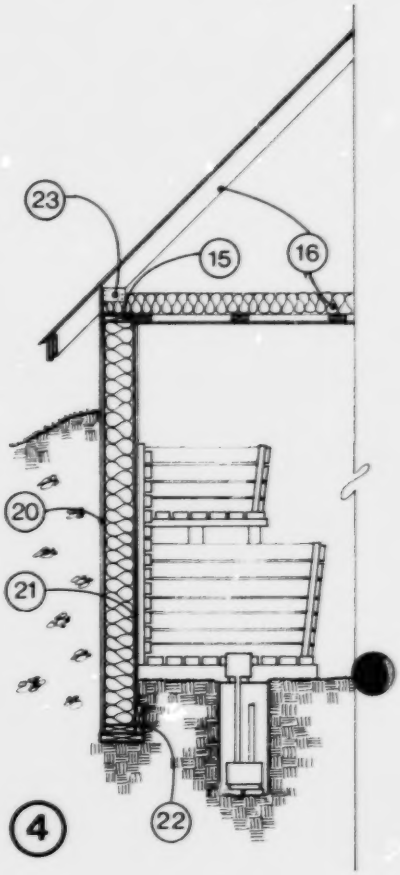

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15. treated top plate and ceiling joist
16. 2 x 4 rafter and ceiling joists at 600 mm (2' - 0") oc
17. strapping so ceiling braces side walls
    loose fill or batt insulation to RSI - 6.0 (R35) over 0.15 mm (6 mil) vapor barrier and plywood
18. ceiling
19. plywood roofing with asphalt shingles or steel roofing
20. 15 mm (5/8") treated plywood under polyethylene or asphalt moisture barrier
21. untreated interior sheathing over 0.15 mm (6 mil) vapor barrier, RSI 5.0 (R28) batt insulation
22. 2 x 8 treated sill and inside bearing plate
23. connect with 200 x 200 (8" x 8") by 12.5 mm (1/2") plywood gussets
24. cold air intake duct
25. warm air exhaust duct [ducts of 200 mm (8") plastic pipe insulate to prevent condensation]
26. slide closure
27. sump, if high water table danger
28. flat roof with straw bales and earth cover; 2 x 10 treated joists or 200 mm (8") cedar poles @ 300 mm (12") oc
29. polyethylene moisture barrier

Ventilation

A double ventilation flue will provide the small amount of ventilation required. The exhaust flue takes warmer air from near the ceiling, allowing cold air to fall to the floor through the intake duct. The cold air intake can be a small vent in the door. A 150-200 mm (6-8 in.) sewer pipe is the handiest flue material. Wrap the exhaust flue and the cold air flue that are inside the storage with rigid foam duct or pipe insulation to prevent condensation, frost and dripping problems.

Simple vents may not adequately cool the storage in the fall. For more cooling, leave the door open, shovel snow into the cellar, or use a portable fan if power is within reach. After winter has set in, the vents can usually be closed and plugged with a burlap sack or rag.

Basement cold room

An insulated cold room in the basement can provide a good quality, convenient storage for vegetables. A basement corner, or an area under a porch or bay window, makes an excellent storeroom location.

Uninsulated concrete basement walls provide a cold exterior, while well-insulated frame walls keep out basement heat. Access to outdoor ventilation air is desirable.

Storeroom walls may be framed from 2 x 6 framing, using batt or foam insulation. Use a 0.15 mm (6 mil) polyethylene vapor barrier on the warm (basement) side of the insulation. If plastic foam insulation is used, it must be covered with gyproc or plywood for fire protection.

The storeroom ceiling should be insulated to RSI 3.5 (R-20). The vapor barrier should be on the warm side and above the insulation. Make sure all batt insulation fits snugly, and joints in the vapor barrier are lapped and taped or sealed.

A concrete curb as a base for the inside walls is preferred but not essential. A treated wood bottom plate is also recommended. Use approved PWF wood.

The storeroom should have a snug-fitting insulated door with weather stripping. An excellent door can be home-built of wood framing with 75 mm (3 in.) foam insulation glued to either face of the plywood sheathing.

Ventilation and temperature control

The ventilation system may be manual fan-forced automatic or semi-automatic or you may have complete mechanical refrigeration. The main consideration is the cost, reliability and ease of operation.

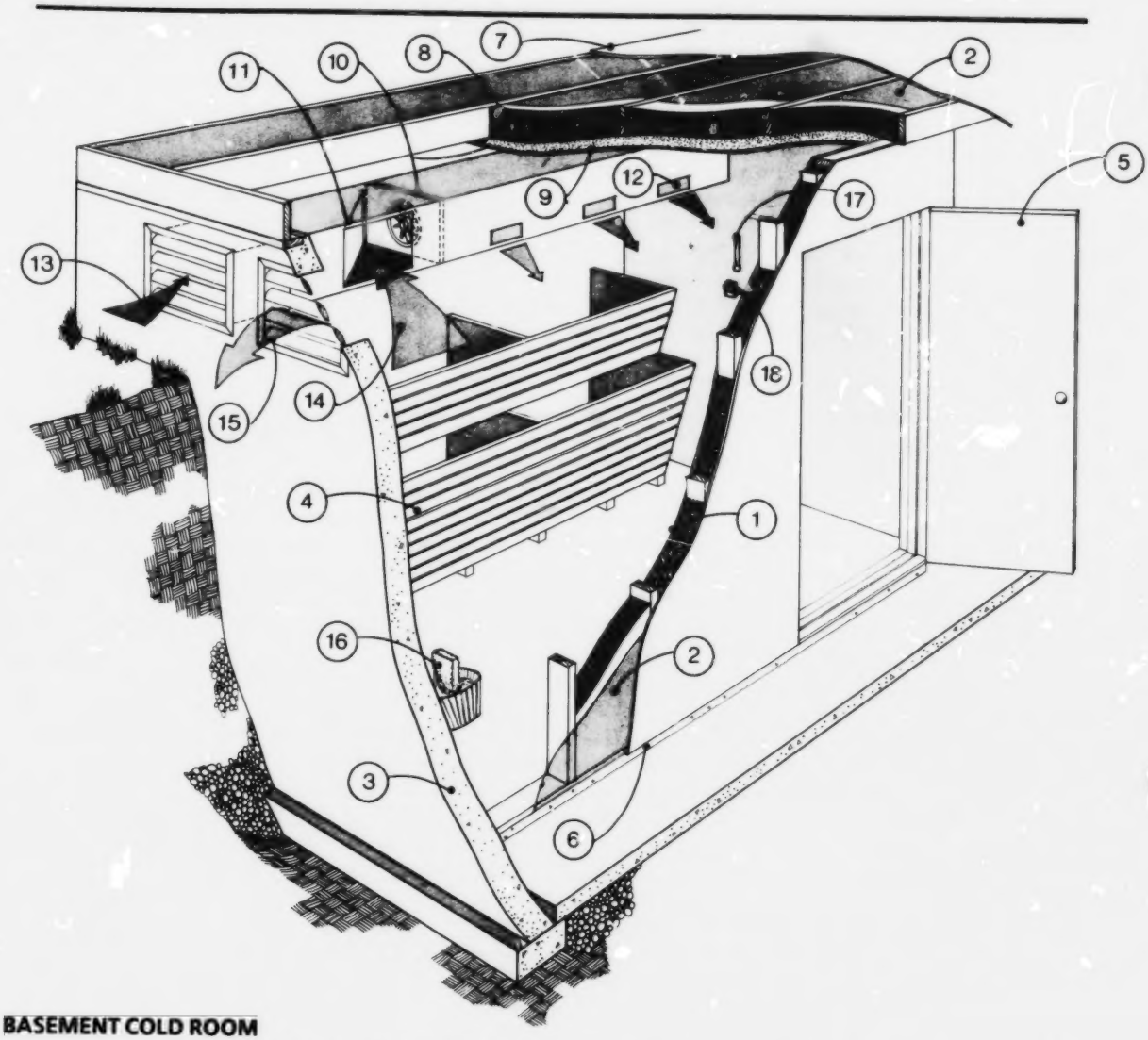
Fan system

A small fan provides the most positive means of temperature control. A small bathroom or kitchen ventilation kit is adequate for most small cold rooms.

The best cold air distribution is achieved when the fan is set up to blow cold air into the storeroom, as illustrated. Warm inside air is displaced and exhausted through a wall vent. For cold weather a small-flap diversion valve on the intake will recirculate some inside air so the intake air is not so cold.

A simple exhaust fan works almost as well, exhausting warm air and letting colder air spill in through a vent. A small circulation fan in the cold room is helpful for mixing this cold air. Both intake and exhaust vents should have self-closing louvres or flaps to prevent unwanted air exchange.

Automatic control can be achieved by using an agricultural (barn) thermostat, or refrigeration control, to start the ventilation fan and to shut it off when the room is cold enough. Be sure to use a thermometer to check that the thermostat operates at the desired temperature. A slightly more complicated system uses a second thermostat outdoors, away from sunlight, wired in series so the fan will not run when outdoor air is too warm to cool the storage.



BASEMENT COLD ROOM

1. insulated stud frame wall 2 x 6 studs @ 600 mm (2' - 0") oc RSI 3.4 (R20) batt insulation
2. 0.15 mm (6 mil) vapor barrier
3. foundation of house
4. bulk storage bins with slatted floor
5. insulated storage door 38 mm (1.5") rigid foam or 90 mm (3.5") batts, minimum. Weatherstrip all round.
6. concrete curb (optional)
7. house floor system
8. RSI 5.0 (R28) batt insulation between joists, or rigid foam insulation below joists
9. interior sheathing of painted plywood or suitable clean surface
10. ventilation fan and duct
11. baffle to blend cold outside air with return air to moderate air temperature
12. blended air at 0 to -10°C
13. outside air
14. warmer, return air
15. exhaust vent
16. add humidity with a humidifer or a blanket in a tub of water
17. thermometer
18. optional, thermostat control for 10

Manual fan operation, turning the fan on by hand, works well but requires close attention to get the desired cooling while avoiding freezing. The safetv and convenience of a thermostat control is usually worth the extra cost.

Manual vents

Manual vents are the least expensive. An exhaust vent placed near the ceiling and an intake duct extending to the floor, each with a slide control, will allow exchange of air to cool the storage. They work best in winter, but may have difficulty cooling a room in the fall unless nights are cold.

Mechanical refrigeration

Mechanical refrigeration gives the best control of temperature year round. A 350-500 W (1000-1500 BTU/h) refrigeration unit is good for the typical 2.5 m x 4 m (8 ft x 14 ft) store room. Outside ventilation is not required. Do not load more than about 1000 kg (2000 lb) per day of produce into the cold room, or the system may be overloaded.